REMARKS

Claims 1-9 are pending. Claims 1, 2, 4 and 5 have been amended. Claim 9 is newly presented. Applicant has carefully reviewed the Examiner's Office Action dated March 31, 2005, in which claims 1-8 are rejected under 35 U.S.C. 103(a) as being unpatentable. Reconsideration and allowance of the present application based on the following remarks are respectfully requested.

Rejection of claims 1, 7 and 8 under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al. (US 6,256,281) in view of Heanue et al (US 6,040,930) is respectfully traversed.

The present invention is related to a holographic digital data storage system which records various holograms in the same spatial location by changing the angle of incidence of the spherical wave as a reference beam (angular multiplexing) and by moving a holographic medium to change a recording area (shift multiplexing).

The present invention provides for recording of various holograms in the same spatial location in the storage medium by reducing the size of the reference beam and changing the incident location of the reference beam on the first lens with the angular selectivity being satisfied to avoid overlapping and yielding different refracted angles of the reference beams. Ultimately, the result is that a

substantial number of holograms of binary data can be stored in the same spatial location in the storage medium on a page-by-page basis. The plane wave (reference beam from the light source) to the first lens becomes a spherical wave after passing through a lens with a different angle. By using the spherical wave, angular multiplexing and shift multiplexing can be achieved. It is also possible to increase the recording density of the storage medium in this manner.

On the other hand, Tanaka et al. teaches a holographic digital data storage system using a plane wave to attain spatial multiplexing (not shift multiplexing). Shift multiplexing cannot be achieved using a plane wave. The apparatus according to Tanaka et al. is characterized by arranging SLM in an optical path of the signal beam optical system and an optical path of the reference beam optical system for shifting the light intensity distribution of the signal beam and the light intensity distribution of the reference beam, respectively, within an area in the recording medium in which the signal beam and the reference beam intersect with each other. In Tanaka et al., the use of lenses makes it difficult to optimize the shape of the reference beam with respect to a recording spot.

In contrast, in the present invention, the incident location of the reduced size of the reference beam on the first lens is changed to yield different refracted angles of the reference beams on the storage medium. Therefore, the invention records various holograms in a same spatial location in the storage medium by using different refracted angles of a incident reference beam which is a

spherical wave. In accordance with the present invention, a lens must be used for producing different refracted angles of the reference beams on the storage medium.

Further, in the present invention, the positions of the transmission regions of the beam selecting means correspond to the selected portions of the reference beam, and the neighboring incident locations of reference beams on the first lens need to be spaced apart from each other by a certain degree for page separation with the angle selectivity being satisfied. Thus, if the SLM 52 in Tanaka et al. is used instead of the beam selecting means of the present invention, the angular selectivity is not satisfied preventing numerous holograms from being recorded in the same spatial location in the storage medium as in the present invention.

Furthermore, the interference pattern in Tanaka et al., using an SLM for spatial multiplexing is different from the interference pattern of the present invention. In Tanaka et al., the pattern is preferably a circular shape whereas, in the subject invention, the reduced reference beam interferes with the entire signal beam and the pattern is a part of rectangular shape. In Tanaka et al. a half of the reference beam interferes with a half of the signal beam because a reference beam is partially blocked. As a result, the intensity of the reproduced beam is smaller than the present invention and SNR (the quality of a reproduced image) is degraded because only a small portion of the beams forms the interference pattern. According to Tanaka et al., there are only 4 combinations of patterns maximally while there is a

plurality of cases by controlling the beam size or the incident angle in the present invention without degrading the intensity of the reproduced beam and SNR. Moreover, in Tanaka et al., the more SLMs are divided, the worse is the SNR. However, in the present invention, as the size of the reference beam is reduced, the size of the incident location is reduced. Therefore, more reduced reference beams having different incident location can be projected into the lens, with the angular selectivity being satisfied, to record numerous holograms in the same spatial location.

Further, in Tanaka et al., each of the SLM is always divided by a central line passing through the optical axis of the signal beam or the reference beam into an optically transparent portion and an optically opaque portion so it is complicated to manufacture in contrast to the present invention.

According to the present invention, the mirrors 210, 212 should be arranged in front of the lens in order to change the position of the reduced reference beam on the lens for angular and shift multiplexing. On the other hand, in Tanaka et al., if the second and third SLM 51' and 52' are arranged at respective intermediate portions of the optical paths of the two beams in Fig.1 (not being in front of the recording medium 10), it is hard to produce a desirable beam for spatial multiplexing because diffraction occurs after passing through the SLM.

Above all, Tanaka et al. discloses spatial multiplexing but does not suggest shift multiplexing. In the present invention, the beam selecting means reduces the size of a reference beam to change the incident location of the reference beam on the first lens to store a great number of holograms of binary data in the storage medium on a page-by-page basis. The lens is used for shift multiplexing. Therefore, it would not have been obvious to one skilled in the art to modify Tanaka et al. to use shift multiplexing to store numerous holograms in the storage medium.

Heanue et al. teaches the use of a lens (50b) only for focusing a beam to a volume holographic storage medium 22, but does not suggest use of a spherical wave reference beam for shift multiplexing.

Accordingly, there is no basis for combining the teachings of Tanaka with Heanue to achieve shift multiplexing using a spherical wave as a reference beam. For all of the above reasons, applicant submits that claim 1 as amended is allowable over the cited references.

Claims 7 and 8 depend from claim 1 and are believed to be allowable for the same reasons indicated above.

Rejection of claim 2 under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al (US 6,256,281) and Heanue et al (US 6,040,930), and further in view of Davis (US 6,486,982)

With regard to amended claim 2, Tanaka et al. uses an SLM as the beam selecting means. Claim 2, which depends from claim 1, is allowable for the same reasons as indicated above in connection with claim 1.

Further, if the beam selection means is an SLM or an LCD shutter, the beam cannot be blocked completely. Therefore, the quality of a reproduced image is degraded. In contrast, the present invention uses an iris as the beam selection means which blocks the reference beam in the non-transmission region completely to vary the incident location of the reference beam on the first lens. By changing, for example, the positions of the iris, the recording density of the holographic medium can be improved.

With respect to an actuator, to change the incident location of the reduced size of reference beam on the first lens, the iris can be moved by the actuator on a two-dimensional plane, e.g., X-axis or Y-axis. Davis uses a limiting aperture which requires a motor for rotation.

As a result, one of ordinary skill in the art would not have been motivated to use an iris as the beam selecting means. Accordingly, applicant respectfully submits that claim 2 as amended is allowable over the references cited.

Rejection of claims 3-6 under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al (US 6,256,281), Heanue et al (US 6,040,930) and Davis (US 6,486,982), and further in view of Hays et al (US 5,777,760) is respectfully traversed

Since claims 3-6 are dependent claims which depend from claim 1, they are believed to be allowable for the same reasons indicated hereinabove with respect to claim 1.

Newly added claim 9 is believed allowable for the same reasons presented above with respect to claim 2 by virtue of its dependence upon claim 2.

CONCLUSION

Applicant believes that this is a full and complete response to the Office Action and that claims 1-8 be allowed in their present form.

Should the Examiner believe that a personal interview might be helpful in advancing this case to allowance, the Examiner is invited to telephone the undersigned.

Reconsideration and allowance of claims 1-9 is respectfully solicited.

Respectfully submitted
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